JOINT STRIKE FIGHTER
the next generation strike fighter

The Role of Metadata in Simulation Based Acquisition Activities

Presentation to NDIA System Engineering Conference 2003

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Topics

- Role of data in modeling and simulation
- Role of metadata in M&S data management
- Verification, validation, and accreditation of data
- Categories of metadata
- Lineage/pedigree metadata
- Metamodel for M&S data mangement
- Applying the metamodel

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Joint Strike Fighter Vision

BE THE MODEL ACQUISITION PROGRAM FOR JOINT SERVICE AND INTERNATIONAL COOPERATION

DEVELOP AND PRODUCE AN AFFORDABLE NEXT GENERATION STRIKE FIGHTER WEAPON SYSTEM AND SUSTAIN IT WORLDWIDE

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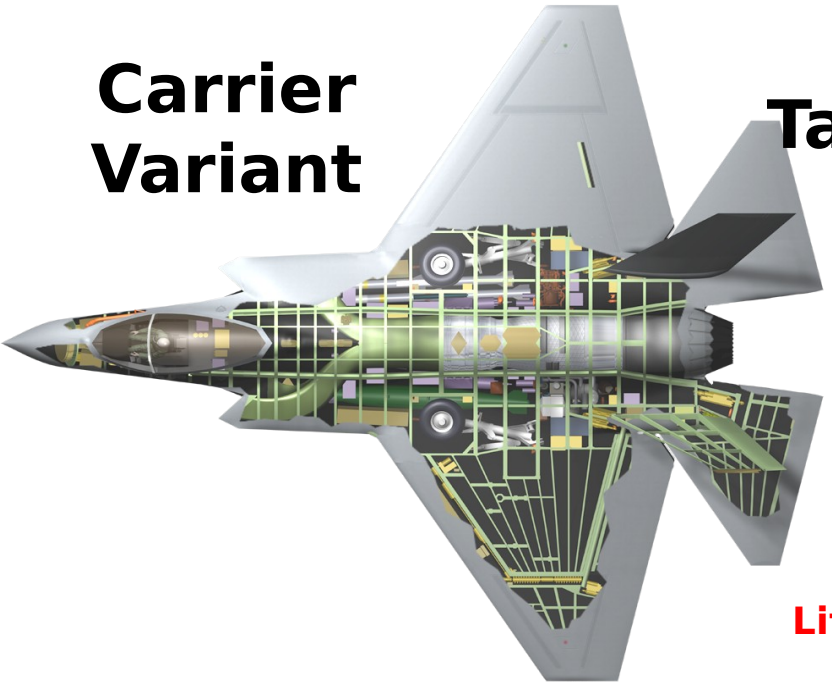
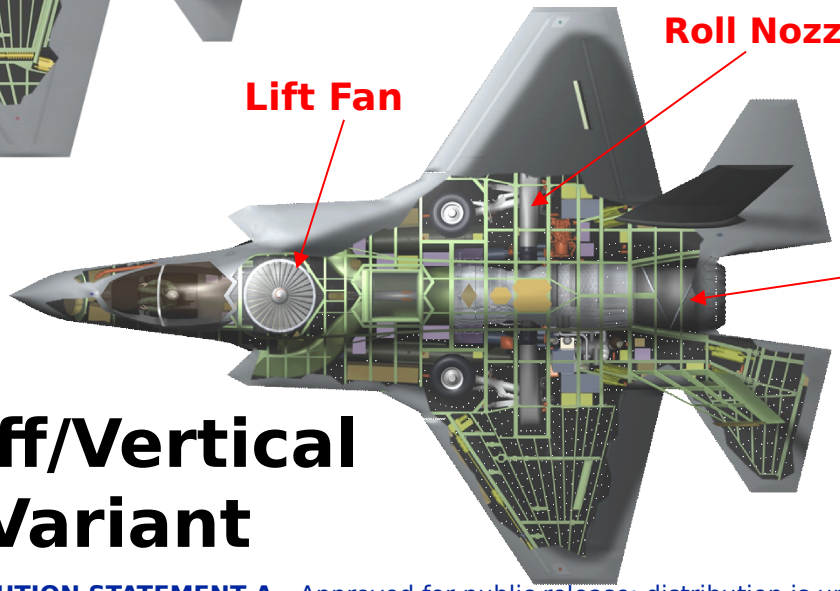
JSF Variants

Carrier Variant



Conventional Takeoff and Landing Variant



Short Takeoff/Vertical Landing Variant

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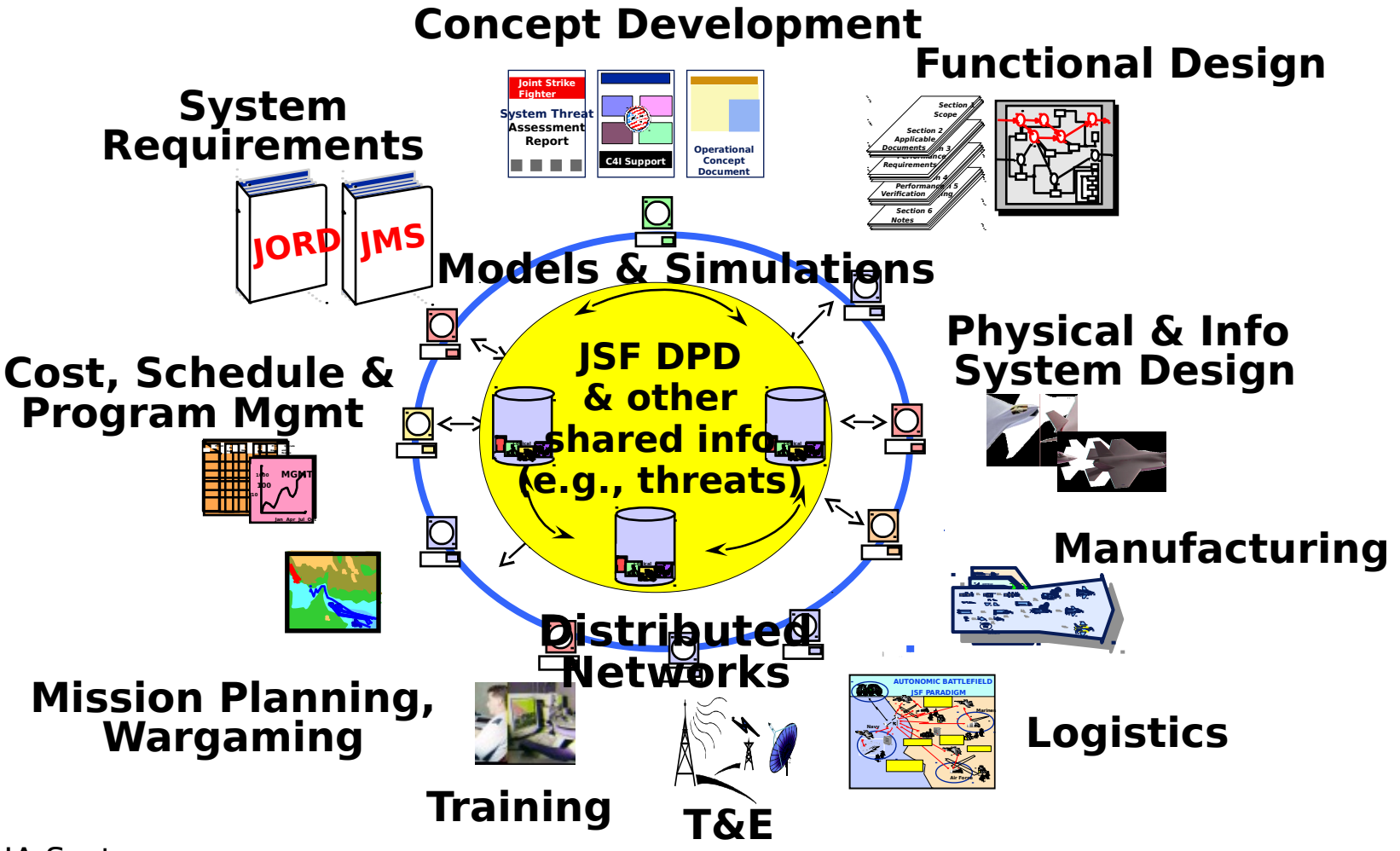
Simulation Based Acquisition

(JSF M&S Support Plan Fig. 5-3)



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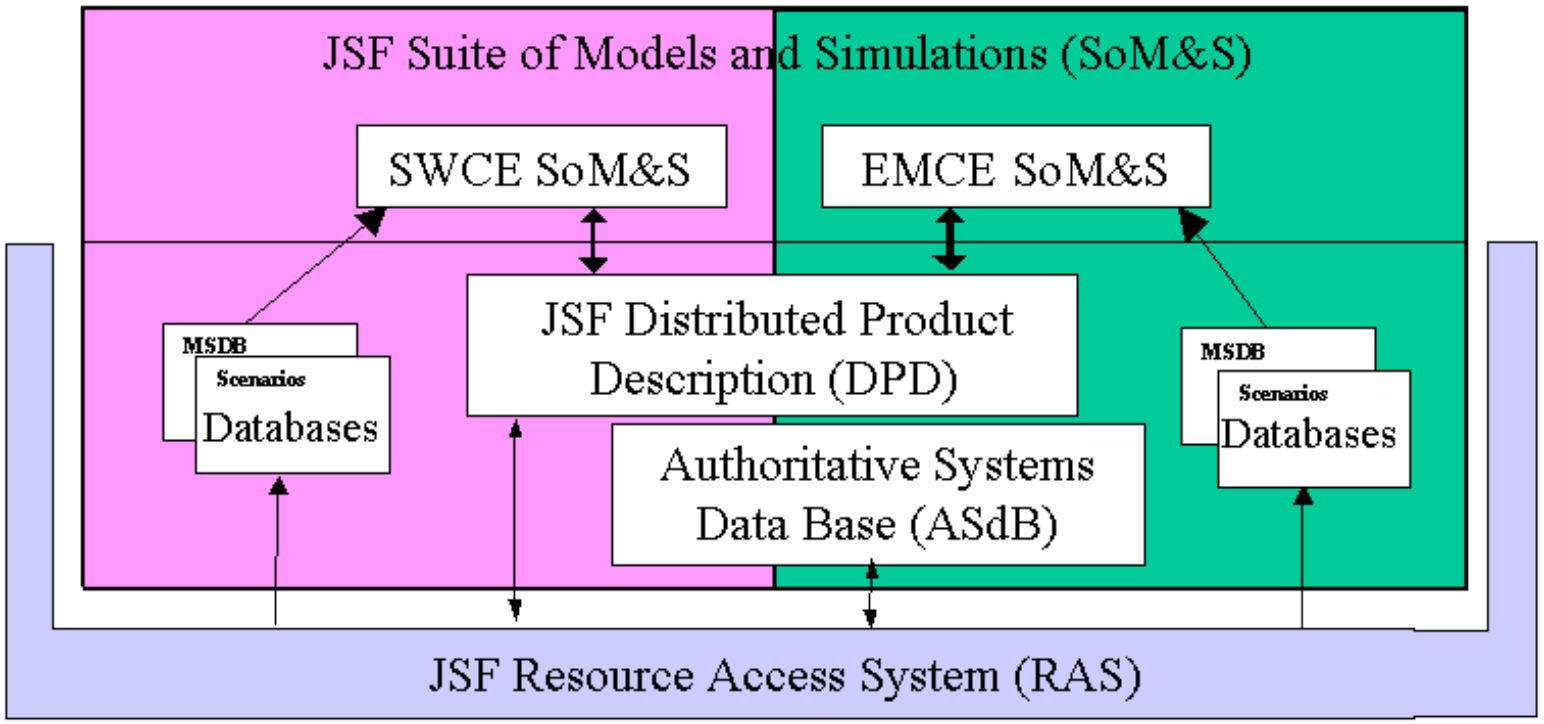
Components of the JSF M&S Toolset

(JSF M&S Support Plan Fig. 5-1)

Strike Warfare Collaborative Environment (SWCE) Toolset

Engineering & Manufacturing Collaborative Environment (EMCE) Toolset



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JSF Authoritative Modeling Information System (JAMIS) Concept

Register proposed designs (LM Aero)

Resource Access System (RAS)

- JSF [DPD]
- Interactions (P_d, P_k, etc.)
- Threat & friendly systems [ASDB]
- Natural environment, infrastructure
- Operational context
- Study-specific archives
- User interface admin data

Linking Standards (mapping semantics/syntax)

Digital System Models

Design change orders

Register design decision

JSF design change decisions

JSF control boards

Program Offices

Blue system C&P info

Intel Centers

Threat C&P information

NIMA, DTRA, NRO, etc.

Natural environment & infrastructure C&P info

Services, JFCOM, etc.

Operational context info

Register authoritative data (JSFPO)

Register smoothed / analyzed results

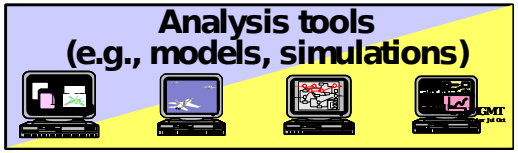
Design change MoMs

Relevant info / DSMs in tool-specific form

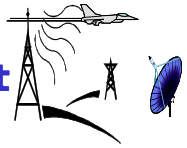
Analyst action

Raw M&S results

Study-specific input datasets & software code



LM Aero Team, Operational Test Authorities



Register DT & OT test results

Color key:

- JSFPO provided
- LM Aero provided

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Data Engineering for Simulation Based Acquisition

- Modeling and simulation is the cornerstone of the complete product lifecycle in SBA. Data is the fuel that drives M&S and the product of M&S.
- The Distributed Product Description alone is not enough. Data engineering for an SBA project must address:
  - Information about the system under development (DPD)
  - Information about the systems with which it will interact
  - Information about the environment in which these systems will operate
  - Information about the operational context in which analyses are performed (scenarios, use cases, firing doctrine, …)
- Data coherency must be maintained
  - Temporal coherence - data being used for different tools and sites represents the same point in the lifecycle development timeline
  - Organizational coherence – organizations across the enterprise are using the same set of databases
  - Layer (tier, level, stratum) coherence - information at a given level of abstraction (e.g., engagement level) is logically consistent
  - Granularity coherence - information at different levels of abstraction is logically consistent

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Goals for JSF M&S Metadata

- Provide a navigation path to allow users to locate data used by, produced by, and related to M&S activities.
- Provide descriptions of data sufficient for the user to understand what they are accessing.
- Provide pedigree metadata that tracks
  - the lineage of data
  - any assessments of quality
  - the appropriate uses of the data.

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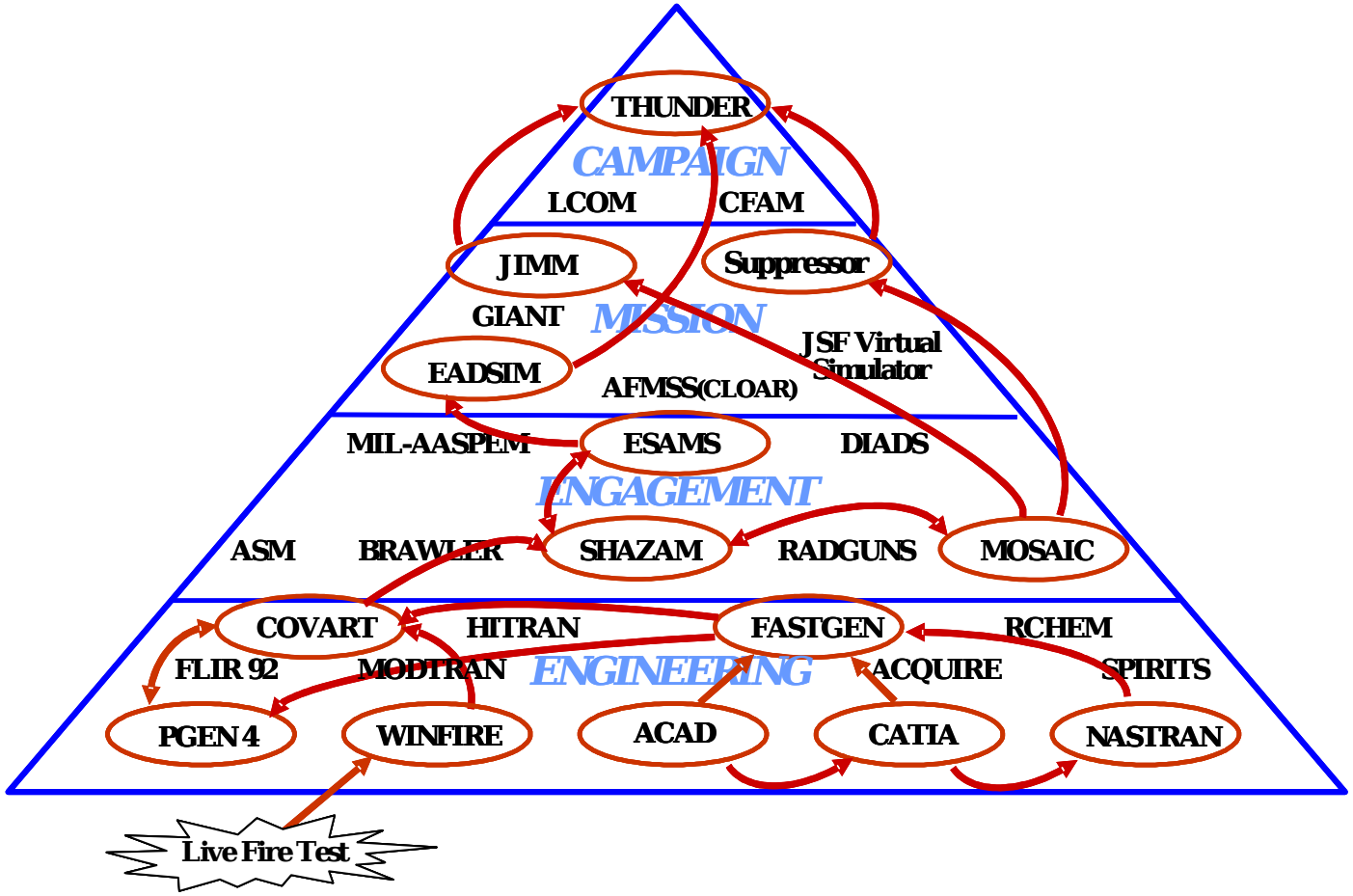
Example of JSF Data Lineage



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M&S Verification, Validation, and Accreditation (VV&A)

From DoD Instruction 5000.61 (DoD M&S VV&A)

- **Verification** - The process of determining that a model implementation and its associated data accurately represents the developer's conceptual description and specifications.
- **Validation** - The process of determining the degree to which a model and its associated data are an accurate representation of the real-world from the perspective of the intended uses of the model.
- **Accreditation** - The official certification that a model, simulation, or federation of models and simulations and its associated data are acceptable for use for a specific purpose.

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Metadata Types

- Structure metadata
  - Metadata applicable to all instances of a type of data (e.g., data element definitions, datatypes, entity relationships, data element relationships, etc.)
  - Example: ISO 11179
- Pedigree metadata (aka instance metadata)
  - Data set/data value metadata
  - Example: Dublin Core
  - Metadata about the instance data in the JAMIS regarding source, use, lineage, and VV&A

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JAMIS Metadata Products

- JAMIS Metamodel
  - Relational metamodel represented in IDEF1X
  - Data dictionary
  - Tabular representation in Excel
  - XML Schema
  - GUI Implementation
- JAMIS Information Model – defines the navigation path relationships for all RAS data
- ASDB Information Model – defines the detailed relationship in the ASDB
  - also defined in IDEF1X

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Sources for the JAMIS Metamodel

- The Dublin Core Metadata Element Set
- Department of Defense Discovery Metadata Standard
- DoD VV&A Recommended Practices Guide
- The combined experience of the JSF Modeling Information Sources Action Team
  - JSF PO and supporting organizations
  - LM Aero
  - Paradigm Technologies, Inc.

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Major Metadata Concepts

- Information Model – A set of nodes in an information tree(s) and their relationships that 1) define information composition and 2) allow users to locate data.
- Information Model Element – A single node in the Information Model.
- Data Item Type –A type of data that can be associated with one or more information model elements (e.g. Brawler dataset).
- Data Item – An individual instance of a data item type, associated with some node of the information model.
- JAMIS Metamodel – The specification of the metadata that formalizes the concepts above and their relationships.

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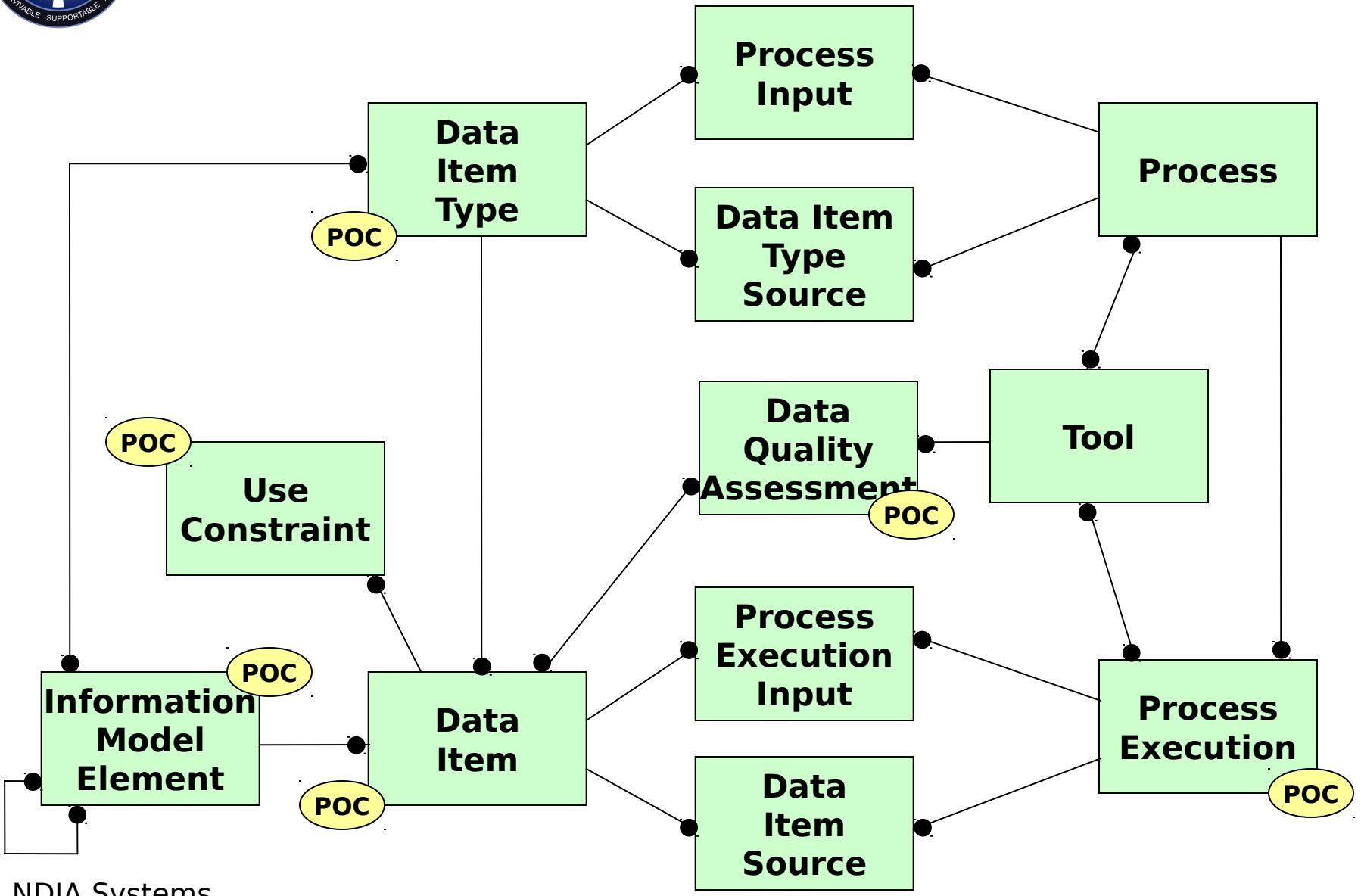
JAMIS Metamodel



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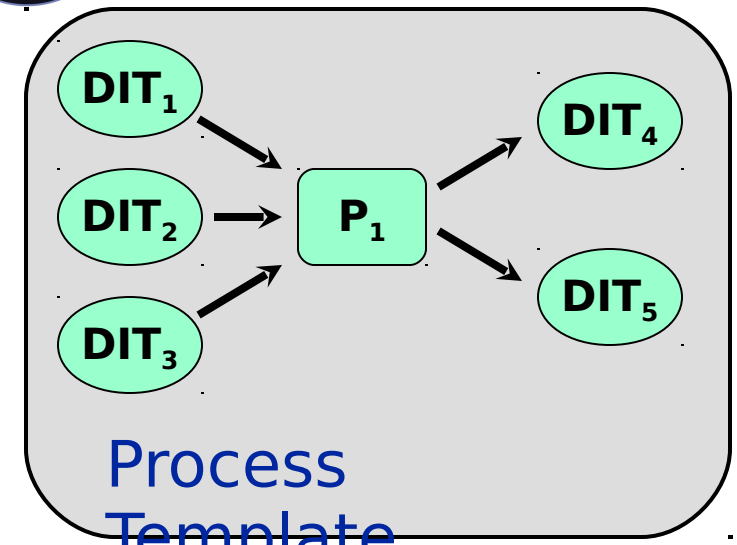
Use of Process Definitions

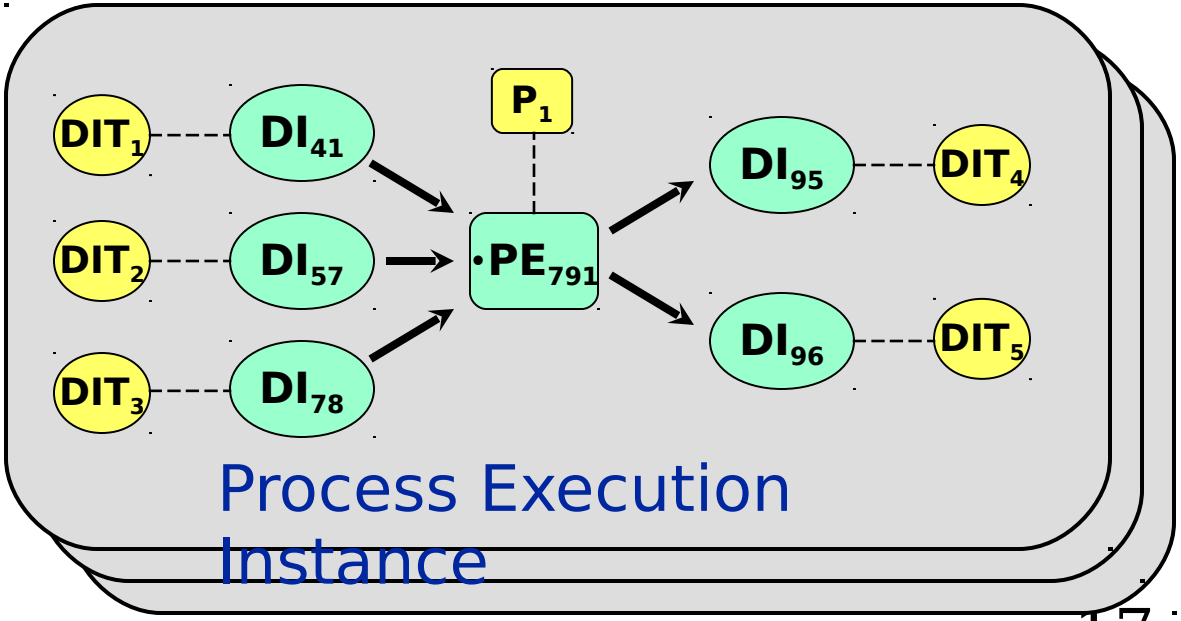


Process Template

DIT – Data Item Type
DI – Data Item
P – Process
PE – Process Execution

used to

- **pre-populate**
- **validate**



Process Execution Instance

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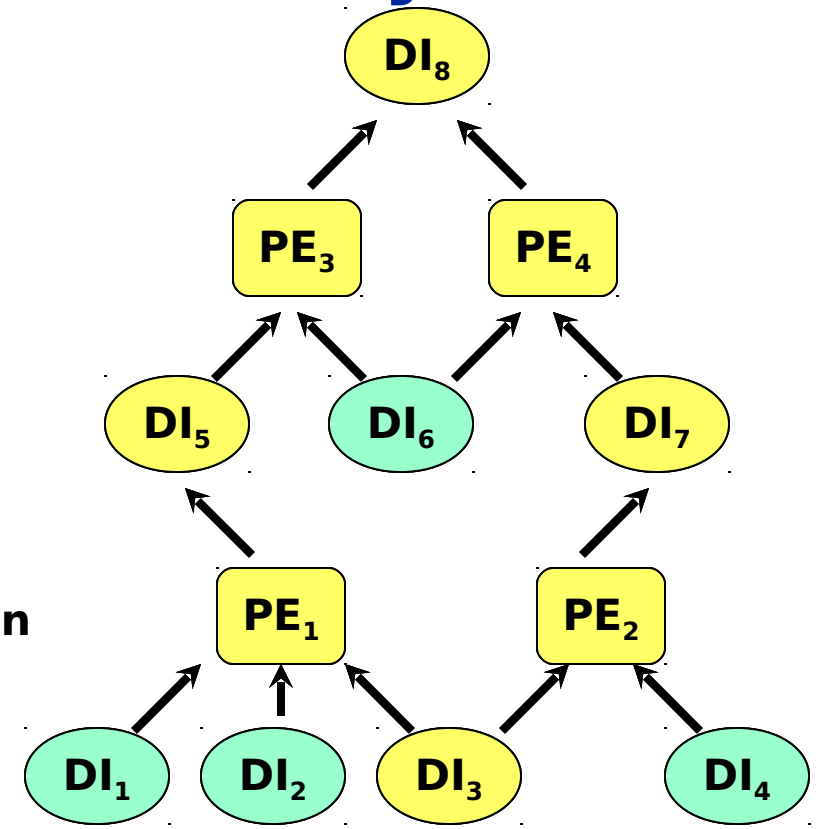
Impact Analysis and Consistency



DI – Data Item
PE – Process Execution

<u>Impact Analysis:</u> A change in D1 potentially necessitates the re-execution of PE1 and PE3 to produce DI5 and DI8.

<u>Consistency</u>: A consistent version of DI3 must be used to eventually produce a coherent version of DI8.

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Implementing the Metamodel for Product Data

- LM Aero will use a variety of product data management (PDM) systems to manage JSF data
  - Metaphase
  - LiveLink
  - Merant PVCS
- The RAS will provide the common access to data in the PDM systems
- Options for managing metadata
  - Manage metadata in the individual PDM systems
  - Manage metadata in the RAS
  - Split the responsibility between the PDM systems and the RAS

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Implementing the Metamodel for Threat and Friendly System Data

- PTI uses Oracle databases for the implementation of the Authoritative Systems Database
- A linking model allows metadata to be associated with the appropriate “slice” of a relational database. Thus a data item can be
  - an entire database
  - a table or set of tables
  - a subset of the rows and/or columns
  - Individual data values (row-column intersections)
- Thus, metadata is not unnecessarily duplicated

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Conclusions

- Metadata is critical to managing M&S data
- In addition to traditional structure metadata, pedigree metadata is needed to understand the lineage, quality, and use of data
- The JAMIS metamodel provides a reasonable approach to capturing the necessary metadata
- The JAMIS metamodel is currently being implemented in the management of JSF M&S data
- For a related paper, see
  - www.sisostds.org
  - Look for paper 03F-SIW-097 from the Fall

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